

4.2 Hydrology and Flooding

4.2.1 Introduction

This section describes existing hydrologic processes and resources, with a focus on surface water hydrology, geomorphology, and flooding, and assesses potential impacts on these resources as a result of implementing the Russian River Estuary Management Project (Estuary Management Project or proposed project). As previously noted in **Chapter 2.0, Project Description**, the Estuary Study Area comprises the Russian River Estuary (Estuary), which extends approximately seven miles from the mouth of the Russian River upstream to just beyond the confluence of Austin Creek. Under certain closed conditions, the Estuary may backwater to Monte Rio, and as far upstream as Vacation Beach. Although this condition may periodically occur, potential impacts related to hydrology are generally thought to be limited to the seven mile area downstream of Austin Creek. Where appropriate, discussion of hydrology impacts within the Estuary Study Area and the larger maximum backwater area, which extends upstream past Austin Creek approximately to Vacation Beach, is provided (Please refer to **Figure 2-3 in Section 2.0, Project Description**). Impacts on hydrologic processes and resources are analyzed in accordance with the California Environmental Quality Act (CEQA) significance criteria (CEQA Guidelines, Appendix G). Existing conditions and potential impacts on water quality, including groundwater resources, are addressed in **Section 4.3, Water Quality**. Fisheries resources, including aquatic habitat conditions, are addressed in **Section 4.5, Fisheries**. Geology and geomorphology information is provided in **Section 4.1, Geology and Soils**.

4.2.2 Setting

Regional Setting and Climate

The project area is located in the coastal region of northern California and is characterized by northwest-trending mountain ranges and intervening alluvial valleys. Hills and mountains comprise approximately 85 percent of the Russian River watershed, and valleys make up the remaining 15 percent. The watershed is bordered on the west by the Coast Ranges and on the east by the Mayacamas Mountains, with the Sonoma Mountains lying in the southeastern part of the watershed. The topography of the Russian River watershed greatly influences localized weather patterns (i.e., the distribution and variability of wind, temperature, and precipitation).

The region and project area are characterized by a Mediterranean climate (i.e., cool, wet winters and warm, dry summers). The coastal areas of the Russian River watershed are heavily influenced by the typically foggy, marine weather. Watershed-wide, the mean annual precipitation is 41 inches, with a range of 22 to 80 inches (USACE, 2004). The greatest annual precipitation occurs at high elevations and in the coastal mountains near Cazadero, while the lowest annual precipitation occurs in the southern Santa Rosa plain. Near the Russian River Estuary (i.e., as recorded at Guerneville), the mean annual precipitation is about 50 inches (WRCC, 2010a; WRCC, 2010b). Annually, the vast majority of rainfall and subsequent runoff occurs from November through April during Pacific frontal storms.

Surface Water Hydrology and Drainage

Russian River Watershed

Upstream of its mouth at Jenner, California, the Russian River drains an area of 1,485 square miles (**Figure 4.2-1**) and flows through a series of broad, northwest-trending alluvial valleys separated by narrow bedrock canyons (PWA, 1997). The Russian River flows southward from its headwaters through valleys and past the cities of Ukiah, Cloverdale, and Healdsburg before turning west at Mirabel Park. From Mirabel Park to the Pacific Ocean, low mountains along both banks comprising the Coast Ranges generally confine the river for the remaining 22 miles. There are several significant tributaries to the mainstem of the Russian River, including the East Fork Russian River (north of Ukiah, and regulated by Coyote Valley Dam), Big Sulphur Creek (near Cloverdale), Dry Creek (regulated by Warm Springs Dam), Mark West Creek and the Laguna de Santa Rosa in the southern portion of the watershed (i.e., downstream of the Dry Creek confluence), and Austin and Dutch Bill Creeks in the Monte Rio/Duncans Mills area.

Existing Hydrologic Regime and Controls

In general, the existing hydrology of the lower Russian River is characterized by large, variable peak flows during the wet-season, in response to rainfall events, and anthropogenically sustained base flows during the dry-season on the order of 50 to 200 cubic feet per second (cfs). The U.S. Geological Survey (USGS) operates a gage on the Russian River near Guerneville (USGS Guerneville gage),¹ approximately 21 river miles upstream from the mouth the Estuary. Daily flows recorded at this gage represent an approximation of the daily flow input to the Estuary (from upstream). Since October of 1983 (i.e., since the installation of Warm Springs Dam, see below), the average annual daily flow of the Russian River at the USGS Guerneville gage has been approximately 2,043 cfs (i.e., through water year 2009).² During the lagoon management period (i.e., from May 15 through October 15), the average daily flow at this gage has been approximately 263 cfs. The average daily flow of the Russian River for each month, as recorded at the USGS Guerneville gage, is summarized in **Table 4.2-1**. River flows typically decline rapidly over the five month lagoon management period. Flows in May averaged 767 cfs for the years 1939 to 2009, and averaged 178 cfs in September for the same time period.

The hydrologic regime of the Russian River includes man-made structures (e.g., permanent and seasonal dams, small diversions). Principal among these are the two dams that impound the two largest reservoirs in the Russian River watershed: Coyote Valley Dam (Lake Mendocino) and Warm Springs Dam (Lake Sonoma). The water managed at the dams account for approximately 15 percent of the total Russian River watershed and are operated primarily for flood control and water supply purposes. Releases are made from the dams to meet downstream water supply requirements, to meet minimum instream flow requirements as established in the State Water Resources Control Board's Decision 1610 (D1610), and/or to increase available storage capacity. Releases from the dams are controlled by the Water Agency (water supply) and the U.S. Army

¹ USGS Gage 11467000, Russian River near Guerneville, California.

² A water year begins on October 1 of the previous year and ends on September 30 of the designated water year. For example, water year 2004 comprises October 1, 2003, through September 30, 2004.



SOURCE: Sonoma County Water Agency

Russian River Estuary Management Project . 207734.01

Figure 4.2-1
Russian River Watershed

**TABLE 4.2-1
RUSSIAN RIVER MONTHLY AVERAGE FLOWS, USGS GUERNEVILLE GAGE
(WATER YEARS 1984-2009)**

Month or Season	Average Annual Daily Flow (cfs)
January	5,925
February	6,590
March	4,488
April	1,693
May	786
June	332
July	193
August	167
September	169
October	205
November	814
December	3,392
Annual (water year)	2,043

SOURCE: ESA Calculated from data presented in USGS, 2010.

Corps of Engineers (USACE) (flood control). In general, dam operations influence the hydrologic regime by reducing the magnitude of peak flood flows and increasing the magnitude and duration of wet- and dry-season base flows. Historically, summer flows were much lower in the main stem of the Russian River (USACE, 2004).

Existing Geomorphic Characteristics

The existing geomorphic characteristics of the Russian River are a reflection of both historic, natural processes and more recent, human-induced changes and influences. The Russian River of the recent geologic past was likely much more dynamic than the present day river. As a result of recent geologic history and land use practices, previous investigations have concurred that the Russian River of today generally flows in an incised, narrow, single-thread channel that is relatively straight and, to a great degree, confined from lateral movement (SHG, 2008; PWA, 1997; SLA, 1991).

Fluvial processes, as well as human activities, within the entire Russian River watershed greatly influence the morphology of the Estuary, as they control the yield of sediment to the Estuary and, ultimately, the Pacific Ocean. Estimates of the average amount of sediment delivered to the lower Russian River and the Estuary vary. Graca (1976, *as cited by* Goodwin et al., 1993) estimated the total sediment amount (i.e., beach material) discharged at the mouth of the Russian River, including both bed load and suspended load materials, to be approximately 267,000 tons per year.³ More recently, Simons, Li and Associates, Inc. (SLA) (1991, *as cited by* Goodwin et al., 1993) have

³ Sediment transport is often separated into two classes based on how grains move: *bed load*, wherein grains move along or near the bed, and *suspended load*, wherein grains are picked up off the bed and move through the water column (generally in wavy paths). Sediment transport can also be organized into two classes by grain source: *bed material load*, which is composed of grains found in the stream bed, and *wash load*, which is composed of the very fine grains found only in small (e.g., less than 1 or 2 percent) amounts in the bed, and which are almost always carried in suspension.

estimated that the bed material load passing through the lower end of the middle reach of the Russian River (i.e., Hacienda Bridge) is approximately 242,000 tons per year. For the period 1981 to 1991, this figure was revised to 110,000 tons per year by Philip Williams & Associates, Ltd. (PWA) (1992, *as cited by* Goodwin et al., 1993). The lower reach of the Russian River is relatively stable compared to upstream areas, with little net change in the annual sediment budget (i.e., the difference between deposition and erosion) (Goodwin et al., 1993; PWA, 1995).

Flooding (Wet Season)

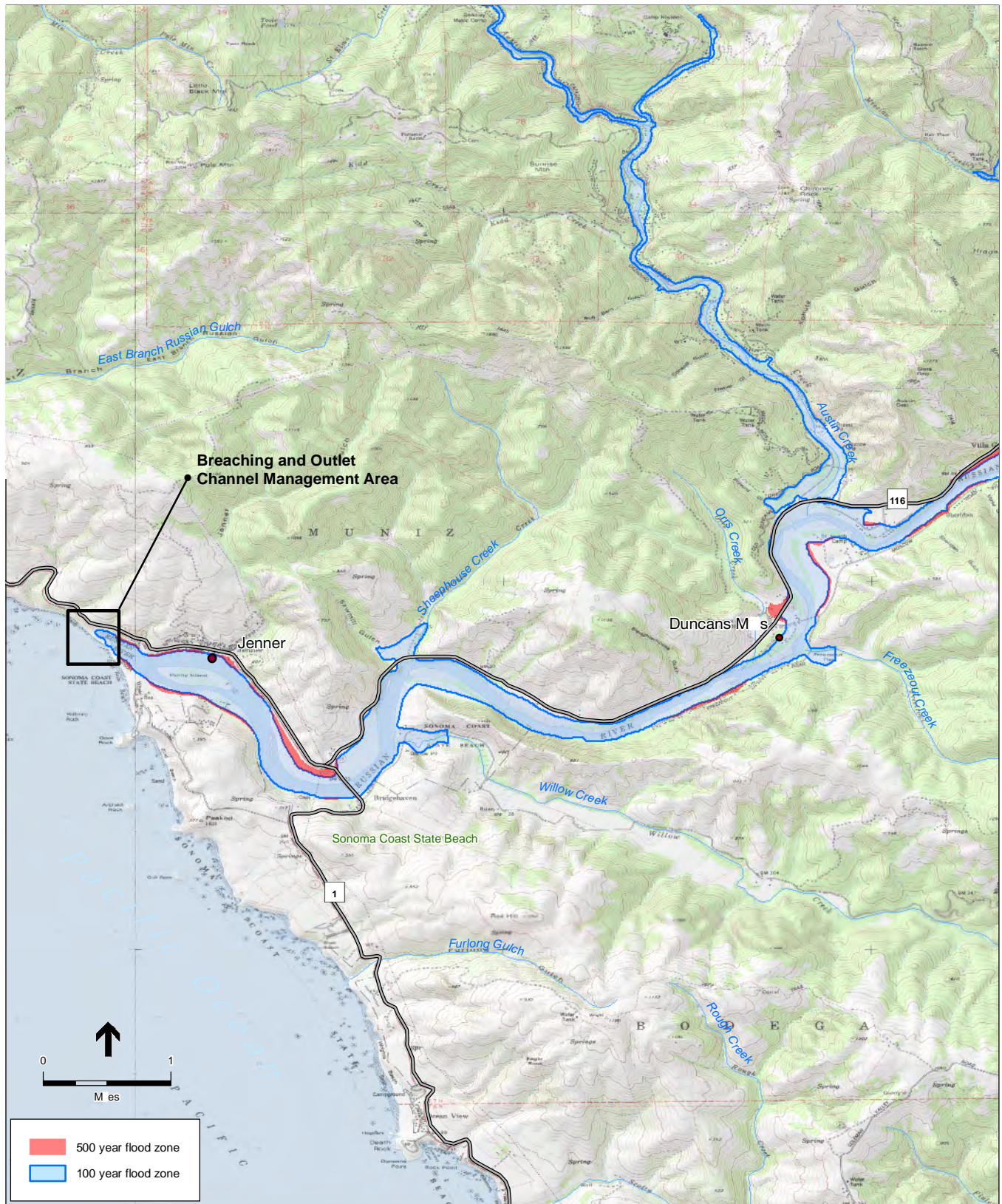
Significant historic floods occurred on the Russian River in Sonoma County in 1955, 1964, 1986, 1995, 1997, and, most recently, in January of 2006. Large portions of the low-lying floodplain adjacent to the river are inundated during high magnitude floods. However, as mentioned previously, the extent of the floodplain within the lower Russian River, including the Estuary, is relatively narrow due to the confined nature of the channel. Floods on small streams usually peak and recede quickly, while floods on the lower Russian River may not peak for two days or more after the start of a storm, and may exceed flood stage for four days or more (County of Sonoma PRMD, 2008). During large flood events the Estuary is typically open to the Pacific Ocean. As discussed in **Chapter 2.0, Project Description**, the Water Agency actively manages water surface elevations in the Estuary during closed conditions. The largest flows recorded by the USGS Guerneville gage were 93,400 cfs in December of 1964, 102,000 cfs in February of 1986, and 93,900 cfs in January of 1995.

The Federal Emergency Management Agency (FEMA) is responsible for mapping areas subject to flooding during a 100-year flood event (i.e., the event with a 1 percent chance of occurring in any given year). According to FEMA (2008a), most of the area of the Estuary below the 7-foot elevation contour occurs within the 100-year flood zone (**Figure 4.2-2** and **Figure 4.2-2a**). The flood zone is relatively narrow and generally follows the flow path of the main channel. Moving upstream from the Estuary mouth, the elevation of the 100-year flood zone (i.e., the base flood elevation) becomes progressively higher than the water surface elevations associated with the periodic formation of the barrier beach during the dry season (e.g., within the proposed lagoon management period). For example, just 1,500 feet upstream of the Estuary mouth, the base flood elevation is approximated at 12.5 feet (NGVD 29) (FEMA, 2008b);⁴ near the confluence of Austin Creek, the base flood elevation of the Russian River is approximately 33.1 feet (FEMA, 2008b). At Hacienda it is approximated at 69 feet (NGVD 29) (FEMA, 2008b).

Tsunamis

A tsunami is a series of traveling ocean waves generated by some kind of rare, catastrophic event, including earthquakes, submarine landslides, and volcanic eruptions. Tsunamis can travel over the ocean surface at speeds of 400 to 500 miles per hour or more, and wave heights at the shore can range from inches to in excess of 50 feet (County of Sonoma, 2006; County of Sonoma PRMD, 2008). Factors influencing the size and speed of a tsunami include the source and

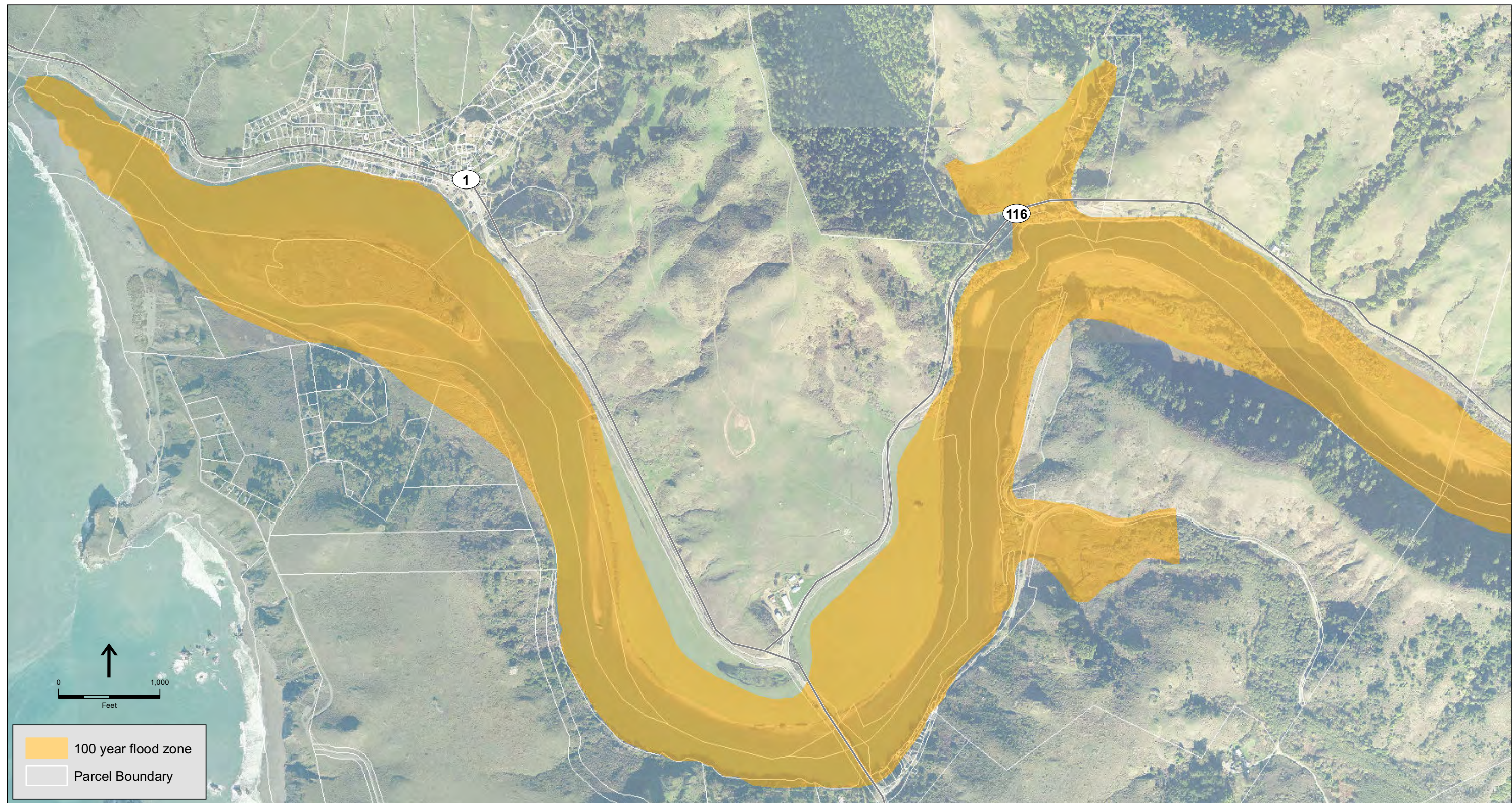
⁴ Herein, all specific elevation values presented (in feet) in Section 4.2, Hydrology and Flooding, are in reference to the National Geodetic Vertical Datum of 1929 (NGVD 29), unless otherwise noted.



SOURCE: FEMA, December 2008

Russian River Estuary Management Project. 207734.01

Figure 4.2-2
FEMA Flood Zones - Jenner Gage



SOURCE: SCWA, 2010 (aerial photo, 2008), FEMA, 2008

Russian River Estuary Management Project. 207734.01

Figure 4.2-2a
100 Year FEMA Flood Zone
Jenner Area

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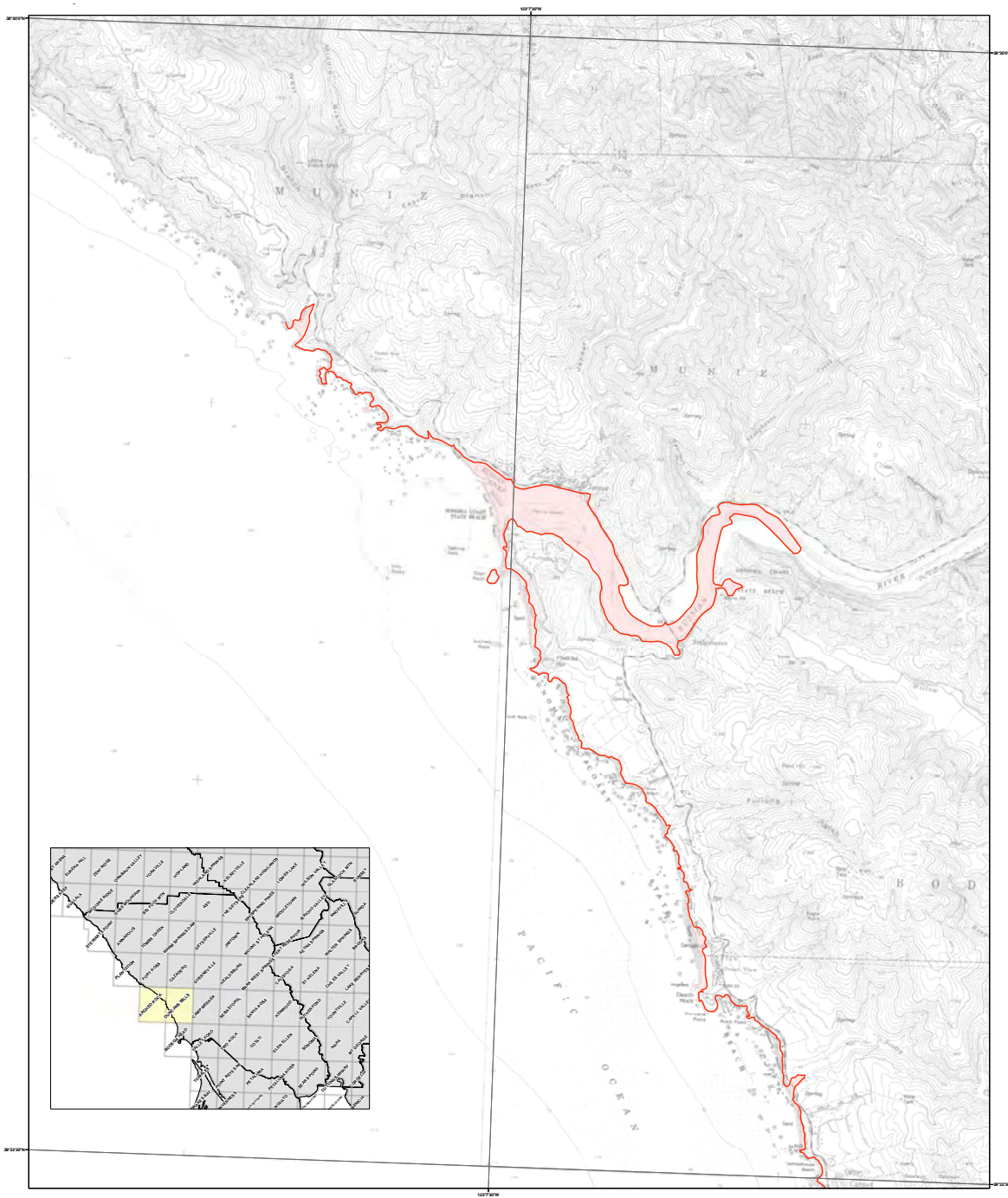
magnitude of the triggering event, as well as off-shore and on-shore topography. There are no historic accounts of tsunamis impacting the Sonoma County coast, however the potential risk remains (County of Sonoma, 2006).

A portion of the Estuary, from the mouth to approximately 3.7 river miles upstream, is within the tsunami inundation zone as mapped by the California Emergency Management Agency (CalEMA) (2009) (**Figure 4.2-3**).⁵ Subsequently, in the event of a tsunami, people or structures within this area could be exposed to a significant risk of loss, injury, or death involving flooding. The tsunami inundation zone as mapped by CalEMA is considered a maximum estimate (i.e., based upon the maximum tsunami runup), taking into consideration a number of extreme, yet realistic, tsunami sources. Tsunamis are extremely rare events, yet there is no specific, quantitative probability information associated with the mapped tsunami inundation zone depicted in Figure 4.2-3.

Climate Change and Sea Level Rise

In recent years, the scientific community has generally reached consensus that climate change and sea level rise are likely to occur. California's position on climate change was formalized in Assembly Bill (AB 32), the California Global Warming Solutions Act of 2006, which states that: "Global warming poses a potential threat to the economic well-being, public health, natural resources, and the environment of California." While scientists agree that sea level rise is likely to occur in the future, the rate of sea level rise is uncertain. Several different estimates have been proposed for planning purposes. For example, the CALFED Independent Science Panel used empirical models based on historic sea level rise to estimate a sea level rise ranging from 20 to 55 inches by 2100 (CALFED Independent Science Board, 2007). The San Francisco Bay Conservation and Development Commission (BCDC) is in the process of developing a strategy to address sea level rise in the future (San Francisco BCDC, 2008). This strategy will identify urban areas that should be protected, other areas that would flood, and how to replace some of the tidal areas that would be impacted. This strategy is not yet developed; therefore it is speculative at this point to describe which areas may be impacted. In response to concerns about climate change and sea level rise, the University of Arizona Department of Geosciences conducted research on factors that determine the degree to which a coastal area is susceptible to sea level rise. This analysis assumes a one meter rise in sea level by 2100 as the worst-case-scenario, and identifies potential impacts to the proposed project. A recent study (Largier, 2010) prepared by a joint working group of the Gulf of the Farallones and Cordell Bank National Marine Sanctuary Advisory Councils identifies and synthesizes potential climate change impacts to habitats and biological communities along the north-central California Coast, over 10 miles south of the project site. Some portions of the project area could be impacted in the future, which could reduce the functionality and effectiveness of the proposed outlet channel and lagoon management strategy. Please refer to **Chapter 5.0, Cumulative Impacts**, for further discussion regarding climate change and resulting potential sea level rise.

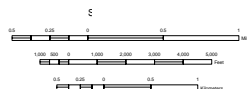
⁵ While this information was not intended for planning purposes, it nonetheless represents the best statewide tsunami mapping effort to date.



TSUNAMI INUNDATION MAP FOR EMERGENCY PLANNING

State of California ~ County of Sonoma
ARCHED ROCK QUADRANGLE
DUNCAN MILLS QUADRANGLE

February 15, 2009



Russian River Estuary

The project site is comprised of the Estuary, which forms the lowest section of the Russian River. The tidal portion of the Russian River Estuary extends approximately seven miles upstream from the mouth to a point between Duncan's Mills and Austin Creek (see Estuary Study Area, **Figure 2-3a in Chapter 2.0, Project Description**). Several Russian River tributaries drain directly to the Estuary, including Dutch Bill Creek, Austin Creek, Freezeout Creek, Sheephouse Creek, Willow Creek, and Jenner Creek. As previously noted in **Chapter 2.0, Project Description**, under certain closed conditions, the Estuary may backwater to Monte Rio, and as far as Vacation Beach (referred to as maximum backwater area).

The Estuary is affected by both coastal and fluvial processes, including general climate and precipitation, nearshore wave action, tides, river discharge and sedimentation (Goodwin et al., 1993). The tidal range at the Estuary mouth is approximately six feet and the tides are diurnal. Mean higher high water (MHHW), as estimated at the Point Reyes buoy, is approximately 3.1 feet and mean lower low water (MLLW) is approximately -2.6 feet (PWA, 2010). At the Estuary mouth, wave action (i.e., wave runup) can increase the water level of the ocean beyond that attributable to just the tides. Sediments in the Estuary are derived from both fluvial (e.g., sands and gravels delivered from upstream) and marine (e.g., sands carried in from the ocean) sources.

The Estuary continues to close throughout the year as a result of a barrier beach forming at the mouth of the Russian River. The barrier beach closes most often in the spring, summer, and fall, when river flows are relatively low and long-period waves transport sand landward, rebuilding the bar that was removed by winter waves and river outflows (SCWA, 2005). The closure of the Estuary temporarily eliminates tidal exchange and initiates pooling of the river flow, which results in a gradual to rapid (i.e., depending on the rate of flow into the Estuary) increase in the elevation of the water within the Estuary.

Estuary Water Level Variations and Management

The Water Agency artificially breaches the barrier beach following a natural closure when the water surface level in the Estuary is between 4.5 and 7.0 feet, as determined by the gage at the Jenner Visitor's Center, in accordance with the *Russian River Estuary Study 1992–1993* (Heckel, 1994). Specifically, when conditions allow (i.e., during safe wave and river flow conditions), the Water Agency ordinarily acts to artificially breach the closed barrier beach to avoid Estuary water levels greater than 9 feet. Water elevations above 9 feet at the Jenner gage could result in flood damage to adjacent properties and/or structures. Following formation of the barrier beach and Estuary closure, natural breaching of the barrier beach occurs when Estuary water levels exceed the capability of the barrier beach to impound this water, causing localized erosion of the barrier beach and creation of a tidal channel that reconnects the Russian River to the Pacific Ocean. This condition depends on the elevation of the barrier beach, and can vary throughout the year. Under existing conditions and management practices, the barrier beach is more often artificially breached by the Water Agency in order to limit or avoid flooding. Under the current management regime, the barrier beach is typically closed for five to 14 days at a time (USACE, 2004). Damages to property have been limited by artificial breaching of the barrier beach.

Since 1996, there have been, on average, six mechanical breaching events per year. Within that timeframe, since June of 1996, the Water Agency has recorded information pertaining to Estuary closure events, including the date on which the barrier beach was breached (by any means, natural or mechanical) and the Estuary water surface elevation at the time of breaching (SCWA, 2010b). Of the 119 documented Estuary closure events between June 1996 and December 2009, an Estuary water surface elevation at the time of breaching was recorded in 101 instances. The lowest recorded water surface elevation upon breaching was 4.3 feet (September 8, 1996); the highest water surface elevation was 11.1 feet, recorded during a natural breach event (November 13, 2001). Of the breaching events for which a water surface elevation was subsequently recorded, over half of the events (i.e., 52 percent) had water surface elevations that exceeded 7 feet (and were sometimes as high as eight, 9, and, in a very few cases, greater than 10 feet).

During a given year, the water surface elevation of the Estuary is well below the elevations typically associated with breaching events and flooding for most of the year. For example, based upon data from the Water Agency's Jenner gage,⁶ the average water surface elevation in the lower portion of the Estuary, from May 2000 through December 2009, was approximately 2.2 feet. Over this same timescale, within the lagoon management period, the average water surface elevation in the lower Estuary was approximately 1.9 feet. Over 99 percent of the time, the Estuary water surface elevation, as recorded at the Water Agency's Jenner gage, was below 7.7 feet.

4.2.3 Regulatory Context

The majority of the regulatory information concerning hydrology and flooding is related specifically to water quality. Information pertaining to water quality regulations, including the federal Clean Water Act (CWA) and the State Porter-Cologne Water Quality Control Act (Porter-Cologne), is discussed and summarized in **Section 4.3, Water Quality**. Relevant regulations, orders, plans, and objectives not related exclusively to water quality are summarized below.

Federal

Executive Order 11988

Under Executive Order 11988, FEMA is responsible for management of floodplain areas defined as the lowland and relatively flat areas adjoining inland and coastal waters subject to a one percent or greater chance of flooding in any given year (i.e., the 100-year floodplain). FEMA requires that local governments covered by federal flood insurance pass and enforce a floodplain management ordinance that specifies minimum requirements for any construction within the 100-year floodplain.

⁶ The Water Agency maintains a recording, water level gage just upstream of the Estuary mouth, at Jenner, on the right bank of the Russian River. The gage records water surface elevations in 0.5-hour increments (some of the earlier data was recorded in 1-hour increments). Data from this gage, for the period 2000-2009, was provided by the Water Agency (SCWA, 2010a).

Local

Local policies established in the *Sonoma County General Plan 2020* that govern hydrologic resources in the project area are summarized in Section 4.2 in **Appendix 4.0, Local Regulatory Framework Governing Environmental Resources**.

4.2.4 Environmental Impacts and Mitigation Measures

This section describes the potential hydrology, flooding, and drainage impacts resulting from the implementation of the proposed project. Potential impacts to water quality, including groundwater resources, are presented in **Section 4.3, Water Quality**, and impacts to fisheries are discussed in **Section 4.5, Fisheries**. Geology and geomorphology information is provided in **Section 4.1, Geology and Soils**.

Significance Criteria

Significance criteria, or thresholds, listed in Appendix G of the CEQA Guidelines are used to determine the significance of potential impacts due to the proposed project. Based on criteria in Appendix G of the CEQA Guidelines, a potential hydrology or flooding impact would be considered significant if the proposed project would result in any of the following:

1. Substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level (e.g., the production rate of pre-existing nearby wells would drop to a level which would not support existing land uses or planned uses for which permits have been granted)
2. Substantially alter the existing drainage pattern of a site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or sedimentation on- or off-site;
3. Substantially alter the existing drainage pattern of a site or area, including through the alteration of the course of a stream or river, or substantially increase the rate or amount of surface runoff in a manner which would result in flooding on- or off-site;
4. Create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff;
5. Place housing within a 100-year flood hazard area as mapped on a federal Flood Hazard Boundary or Flood Insurance Rate Map or other flood hazard delineation map;
6. Place within a 100-year flood hazard area structures which would impede or redirect flood flows;
7. Expose people or structures to a significant risk of loss, injury, or death involving flooding, including flooding as a result of the failure of a levee or dam; or
8. Inundation by seiche, tsunami, or mudflow.

Some of the above-listed CEQA criteria are not considered relevant to the project based upon the proposed project and data research, and therefore, they will not be evaluated further in this EIR. In the case of hydrologic resources:

Groundwater supply depletion or interference with recharge. The Estuary Management Project would not directly deplete groundwater supplies, i.e. it does not include increased pumping to serve land uses enabled by the project, nor does it interfere or eliminate groundwater recharge, i.e. by increasing the amount of impervious surface in a recharge basin. The Estuary Management Project is an adaptive management project that would increase the frequency and duration of higher water levels in the Estuary. Because the proposed project is not anticipated to directly affect groundwater recharge or create a supply in reduction, this impact is not discussed in this section. However, potential for impact to groundwater quality is addressed in **Impact 4.13.4** in **Section 4.3, Water Quality**.

Approach to Analysis

This impact analysis focuses on foreseeable changes to the baseline (or existing) condition in the context of the significance criteria presented above. It should be noted, not all of the criteria listed in Appendix G of the CEQA Guidelines are directly applicable to the proposed project. The ensuing impact analysis is based upon the potential impact of activities that would occur, during the lagoon management period. As noted in **Chapter 2.0, Project Description**, the Water Agency would continue its current practice of artificial breaching outside of the lagoon management period of May 15 through October 15. Timing, implementation, access, sensitivity to pinniped haulout, personnel, equipment and general procedures would be equivalent to current practices, as described in **Section 2.2.2**. No change to artificial breaching outside of the lagoon management period would occur under the Estuary Management Project. The principal project components relevant to the analysis of hydrology and flooding impacts relate to the proposed increase in the water surface elevation within the Estuary and the duration over which that increased elevation would be maintained; these project components are reiterated and summarized below.

As part of the Estuary Management Project described in **Chapter 2.0, Project Description**, following a natural closure of the Russian River mouth and formation of a barrier beach, an outlet channel would be created, managed, and monitored annually within the lagoon management period. The purpose of the outlet channel would be to maintain predominantly freshwater conditions (i.e., a non-tidal state) within the Estuary while minimizing the potential for flooding of low-lying properties. To meet the intended performance criteria, the outlet channel must simultaneously meet two key constraints: 1) convey sufficient discharge from the Estuary to the ocean in order to manage a consistent Estuary water level not to exceed 9 feet mean sea level and that minimizes flooding, and 2) preserve outlet channel function by avoiding closure or breaching.

Within the lagoon management period, the Estuary water level management target would be an average daily water surface elevation of 7 feet. Depending on the conditions at the time of outlet channel establishment (e.g., elevation of the barrier beach, wave and tide conditions, inflow to the

Estuary, etc.), the resulting water surface elevation in the Estuary could range from 4.5 feet up to 9 feet. Under existing conditions, the available data suggest that water surface elevations above 7 feet rarely occur within the Estuary during the lagoon management period. However, the duration over which the target water surface elevations would be maintained would likely increase as a result of implementing the Estuary Management Project.

Impact Analysis

The following impact analysis focuses on potential impacts of the proposed Estuary Management Project related to hydrology. The evaluation considered project plans, current conditions at the project site, and applicable regulations and guidelines. Impacts are summarized and categorized as either “no impact,” “less than significant,” “less than significant with mitigation,” or “significant and unavoidable.”

Impacts and Mitigation Measures

Impact 4.2.1: Alteration of drainage. The creation and maintenance of the outlet channel would alter the existing drainage pattern within the Estuary, and this could result in increased sedimentation or erosion. (Less than Significant)

The creation and maintenance of the outlet channel would have the potential to affect the rate of sediment deposition within the entire Estuary, as well as impact erosion processes and general channel stability at the Estuary mouth. As a result of project implementation, the increased base-level within the Estuary (i.e., the water level controlling the velocity of inflow from upstream of the Estuary), over a more prolonged time period, could cause an increase in the rate at which sediment transported by the Russian River mainstem is deposited within the Estuary. Also, the outlet channel itself could change the general conditions at the Estuary mouth, leading to more erosion or less stable conditions locally. Increased maintenance of the outlet channel would also have the potential to increase localized erosion and resulting sedimentation within the surf zone and Estuary mouth.

Deposition within the Estuary

The lagoon management period generally coincides with the dry-season and, subsequently, there is very little sediment input from upstream during this period (compared to the winter months). From water year 1984 through 2009, during the lagoon management period, the mean daily flow in the Russian River at Guerneville (USGS gage) was approximately 263 cfs, which is less than 6 percent of the mean daily flow value outside of the lagoon management period (3,000 cfs). Sediment transport is typically a non-linear function of discharge (e.g., sediment transport is a power function of discharge, with an exponent greater than one). In other words, the rate at which sediment transport increases is proportionately greater than the rate at which discharge increases. Thus, with respect to the annual sediment load, it is expected that less than 6 percent of the annual sediment load would be transported during the lagoon management period. In fact, it is likely that less than one percent of the annual sediment yield at Guerneville is transported during the lagoon management period. In most alluvial rivers draining the north coast of California, the vast

majority of the annual sediment load is carried by a few, large flood events (e.g., by flows that occur less than 5 percent of the time, on a daily average basis).

On average, little-to-no sediment would be transported into the Estuary during the lagoon management period. Consequently, the proposed change in the base-level of the water surface would have little-to-no impact upon the rate of sediment transport through, or deposition within, the Estuary, and the potential impact of the project upon sedimentation would be less than significant.

Stability of the Outlet Channel

As already described (**Chapter 2.0, Project Description**), given the ranges for stable channel geometry previously determined through geomorphic and hydraulic analysis (PWA, 2010), the target outlet channel dimensions would be established so as to minimize the risk of both erosion (natural breaching) and closure. The dimensions of the outlet channel would be dependent upon beach formation conditions. Ultimately, the outlet channel would be designed and constructed such that its discharge capacity is similar to the rate of flow into the Estuary minus losses due to seepage and evaporation. Regarding erosion and outlet channel stability, the impact discussed herein concerns the way in which the channel could fail and the ensuing effect, if any, this would have upon processes at the Estuary mouth.

Failure of the outlet channel would be by one of two natural processes: closure⁷ or natural breaching (erosion). Both of these processes are currently active within the Estuary. The processes which lead to outlet channel closure are most likely to originate from elevated ocean water levels and wave heights. Elevated ocean water levels would move the active sediment transport zone into the outlet channel, increasing sediment deposition at elevations above that of the outlet channel's bed (PWA, 2010). If the rate of sediment deposition within the outlet channel exceeds the capacity of the channel to remove or scour sediment, then a barrier beach would build at the mouth of the outlet and it would eventually close. Depending upon the water elevation within the Estuary at the time of closure, and the subsequent inflow rate and rate of water level rise, the Water Agency would attempt to re-establish the outlet channel. Within the lagoon management period, consistent with the project goal of reducing tidal influence, the current practice of artificial breaching following closures would theoretically occur less often. However, maintenance of the outlet channel in this fashion may require additional equipment operation on the beach, depending upon performance of the outlet channel. The Water Agency is assuming up to 18 maintenance operations, or approximately once per week. This incremental increase in equipment use for maintenance is not anticipated to increase sedimentation or erosion rates within the barrier beach or active surf zone.

Natural breaching is likely to result from two processes, high discharge which scours the channel bed or seepage-induced bed mobilization (PWA, 2010). Because the outlet channel is an unconsolidated bed composed of relatively small particles (i.e., approximately 1 millimeter in diameter, on average), it is susceptible to scour by the discharge flowing through the outlet channel. If the rate of scour within or at the mouth of the outlet channel is too great the outlet

⁷ All closures would be naturally; not man-made or manipulated.

channel would begin to erode, becoming deeper and wider as the barrier beach is eventually breached and the Estuary again becomes predominantly tidally influenced. These processes can occur simultaneously and work together to create a natural breaching event. Concerning the second potential breaching mechanism, if seepage rates are sufficiently large, the movement of water through the sand can mobilize sand particles where the seepage flow daylight at the ground surface. This process could lead to erosion of the outlet channel and subsequent breaching, similar to that described above for the case of hydraulic scour. When breaching occurs, a large amount of locally-stored sediment (i.e., part of the barrier beach) is usually rapidly excavated and deposited near the landward edge of the surf zone. Within the lagoon management period, consistent with the project goal of reducing tidal influence, this process of breaching and the subsequent sediment movement would theoretically occur less often.

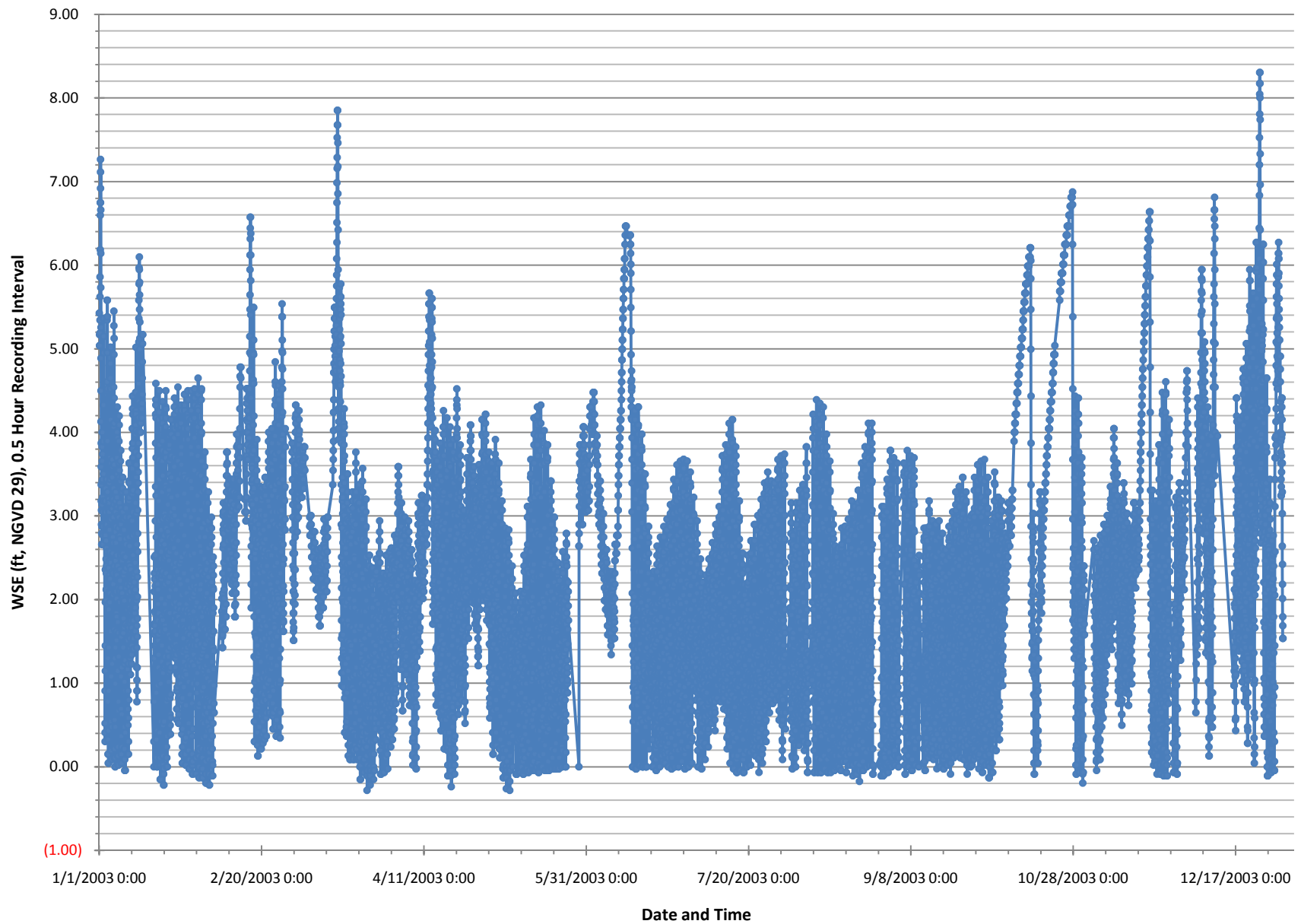
In either case (i.e., closure or breaching), hydraulic and geomorphic conditions at the Estuary mouth upon completion of the given process would be no different as a result of implementing the project. Implementation of the outlet channel would not foster the development of less stable conditions within the Estuary or at the Estuary mouth. Nor would implementation of the outlet channel notably increase the sediment yield to the Estuary or to the ocean. While functioning, it would simply establish an outlet channel at the Estuary mouth, draining the “perched lagoon.” Once a closure or breaching event occurs (as previously described), then the processes of wave-induced deposition or hydraulic or seepage erosion end the equilibrium condition and essentially “reset” the Estuary in the same manner as happens under current conditions during a closure or breaching event (natural or artificial). Therefore, the proposed project is likely to decrease localized erosion at the Estuary outlet associated with current artificial breaching activities, with little or no impact expected to the erosion and beach building processes of the adjacent beaches. The potential impact of the project upon the process and frequency of erosion at the mouth would be less than significant.

Impact Significance: Less than Significant; no mitigation required.

Impact 4.2.2: Property Inundation. The creation and maintenance of the outlet channel would alter the existing drainage pattern at the Estuary mouth, which could result in increased potential for inundation of parcels adjacent to the Estuary. (Significant and Unavoidable)

The range of water surface elevations that occur within the Estuary would not change as a result of implementing the project. However, the duration over which the target water surface elevations (e.g., 4.5 feet to 9 feet, with an average of 7 feet) would be maintained would increase, depending upon the performance of the outlet channel. As shown in **Figure 4.2-4**, the duration of target water surface elevations would be increased from less than a few days, on average, to approximately one to five months, on average, within the lagoon management period. Thus, low-lying areas at or below the 9-foot elevation contour, which are currently naturally inundated⁸ only

⁸ Historically, “inundation” is a naturally occurring condition; existing management is not natural. Allowing the lagoon to form would more closely mimic natural conditions.



SOURCE: SCWA, 2010

Russian River Estuary Management Project . 207734.01
Figure 4.2-4
 Estuary Water Level at Jenner Gauge (2003)
 and Proposed Project Condition

sporadically throughout the year, would remain inundated over much longer durations, on average, during the lagoon management period. As previously discussed in **Chapter 3.0, Project Background and Environmental Setting**, based upon data from the Jenner gage, the average water surface elevation in the lower portion of the Estuary, from May 2000 through December 2009, was approximately 2.2 feet. Over this same period of time, within the lagoon management period, the average water surface elevation in the lower Estuary was approximately 1.9 feet. Over 99 percent of the time, the Estuary water surface elevation, as recorded at the Water Agency's Jenner gage, was below 7.7 feet.

Areas that would be subject to increased durations of inundation include both relatively large, contiguous areas, as well as smaller, more discrete areas immediately adjacent to the active channel margin. The largest relative increase is the area of inundation between the 4.5- and 9-foot contours over the western half of Penny Island, at the mouth of Willow Creek, and over approximately six gravel bars at and upstream of the Willow Creek Environmental Campground (see **Chapter 3.0, Figures 3-4A through 3-4E**). The increase in the duration of inundation at the 7-foot, and, possibly, 9-foot contours in these areas, would not result in a subsequent increase in the potential for damage to existing structures or buildings, as none exist in these areas. Project implementation would not expose people or structures to a significant risk of loss, injury or death related to flooding, the threshold established in Appendix G of the CEQA Guidelines. In this case, and in this context, the increase in the duration of flooding, which currently occurs on an episodic basis, would not be considered a potentially significant impact. However, along more localized areas of the Estuary shoreline, the increase in the duration of flooding between 7 and 9 feet could have a potentially significant impact to property and structures, as further described below.

As described earlier (**Chapter 3.0, Project Background and Environmental Setting**), water surface elevations relative to parcels along the Estuary shoreline were reviewed within the Estuary Study Area, as required by the National Marine Fisheries Service (NMFS) Russian River Biological Opinion. Results of that review indicate that portions of approximately 78 parcels within the Estuary Study Area would be inundated at a water surface elevation of 9 feet. In most cases, the area of inundation would comprise channel margin ("shoreline") and beach areas only, and no structures (e.g., homes, sheds, septic tanks, boat docks, etc.) would be directly affected. However, in a few cases, a preliminary analysis of the Estuary Study Area using aerial photographs, elevation data, and parcel information (SCWA, 2010b) suggests that existing structures, primarily boat docks, would be inundated at a water surface elevation between 7 and 9 feet. The following 9 parcels, identified by Assessor's Parcel Number (APN), are those identified in the aforementioned analysis as containing structures (i.e. buildings and boat docks) that could be inundated at Estuary water surface elevations between 7 and 9 feet: 099-080-008, 099-080-037, 099-120-009 (Visitor Center), 099-140-052, 099-140-055, 099-140-060, 099-140-063, 099-140-065, and 099-140-089. For 7 of the parcels a boat dock or boat ramp could be potentially inundated; for two parcels the structure at risk would be a house or other type of building. The increase in the duration over which these structures would be annually inundated, and for a longer duration, could result in potentially more damage than that which is sustained under existing conditions, as water surfaces are controlled by artificial breaching. Similar impacts

could be associated with increased frequency and duration of higher water surface elevations within the maximum backwater area, extending upstream to approximately Vacation Beach, although a parcel specific analysis was not performed. With respect to these parcels and structures, this would be a potentially significant impact resulting from implementation of the project; **Mitigation Measure 4.2.2** would reduce this impact to the degree feasible relative to structures that may be inundated for a longer duration. However, no mitigation measures are available to reduce or avoid the natural inundation of private parcels to an elevation of up to 9 feet along the Estuary shoreline for longer durations during the lagoon management period. Therefore, these impacts are considered significant and unavoidable.

Mitigation Measure

Mitigation Measure 4.2.2: Concerning the 9 parcels and associated structures (i.e., boat docks or boat ramps on 7 of the parcels, and homes or other buildings on the other two parcels) identified above, and presented in more detail in a previous analysis (SCWA, 2010b), the Water Agency shall coordinate with NMFS and work with the property owners to identify measures that would, if necessary, substantially minimize or avoid any damages to existing structures that would occur as a result of implementing the project (i.e., increased flooding durations at the 7 and 9 foot elevation). As appropriate, the Water Agency shall survey properties within the 9 foot elevation in greater detail to more accurately and precisely determine the elevation of the structures potentially at risk; this information shall be kept on record at the Water Agency and a copy shall be provided to each of the property owners.

Impact Significance after Mitigation: Significant and Unavoidable

Impact 4.2.3: Tsunami Risk. A portion of the project area is located within a mapped tsunami hazard zone, and therefore could be inundated in the unlikely event of a tsunami. Subsequently, increased water levels in the Estuary could increase the risk to people or structures within this area to loss, injury, or death involving flooding in the event of a tsunami. (Significant and Unavoidable) Implementation of the project during the lagoon management period would increase the frequency and duration of higher water levels in the Estuary, thereby reducing the storage capacity of the Estuary for a more prolonged period of time (i.e., as compared to existing conditions). Therefore, could exacerbate the risk of flooding and loss associated with a tsunami, should one occur. Increased Estuary surface water levels (and, subsequently, decreased storage capacity) may result in somewhat higher inland tsunami elevations in the lower portion of the Estuary, should one occur during the lagoon management period. In essence, portions of the Estuary which may retained a portion of the tsunami's flood volume when Estuary water levels are lower would be filled with water as a result of the project, so the overtopping volume from the tsunami may propagate further landward. The exact extent of this probable effect is uncertain. In fact, there is also considerable uncertainty regarding the existing inundation map and the depicted upper bound of inundation (Figure 4.2-3), and even under existing conditions it remains possible that actual inundation could be greater in a major tsunami event (CalEMA, 2009). When a large seismic event occurs that could trigger a tsunami affecting the coast, the Pacific Tsunami

Warning Center and the West Coast and Alaska Tsunami Warning Centers issue tsunami warnings and watches to potentially affected communities (County of Sonoma, 2006); this would include the community in and around Jenner.

In the event of a tsunami during the lagoon management period, the increased Estuary water levels could result in a higher tsunami-related flood inundation elevation. Currently, within the lagoon management period, the average Estuary water surface elevation as recorded by the Water Agency's Jenner gage is approximately 1.9 feet. According to elevation, area and volume data for the Estuary (Brennan, 2010), the volume at 7 and 9 is approximately 2.4 and 3.1 times greater, respectively, than the volume at 1.9 feet, respectively. As such, the storage capacity of the Estuary would be substantially reduced. However, the dynamics of tsunami effects within the Estuary are not well understood and, consequently, neither is the additional effect of reducing storage capacity. Based on the information available, the potential magnitude of increase in the tsunami inundation elevation of the lower Estuary, as a result of project implementation, is uncertain.

Though tsunamis are extremely rare events, and the specific effect of elevated Estuary water levels upon the tsunami flood risk cannot be reliably quantified at this point, the increase in the duration of target Estuary water levels would, nonetheless, likely increase the overall risk of flooding associated with a tsunami. Since the project would increase the average duration of elevated Estuary water levels from less than a few days, on average, to approximately 1 to 5 months, on average, the probability of a tsunami (of sufficient magnitude to cause damage) occurring concurrently with elevated Estuary water levels would also increase. The amount that this increase in concurrent events would increase the tsunami flood risk probability is not known. It should be noted that increased storage conditions currently occur naturally and episodically, but their duration is limited by artificial breaching practices currently implemented by the Water Agency.

In considering the increased duration of higher water surface elevations, and the increase in risk with respect to people, adequate warning would likely be given in the event of a potential tsunami generating event, this would not necessarily mitigate or alleviate the increased risk of loss as it pertains to existing structures or property (i.e. equipment, cattle, etc.). Given the uncertainty of the magnitude of this potential impact, and lacking more Estuary-specific information concerning tsunami effects, in the unlikely event that a tsunami of sufficient magnitude occurs within the Jenner area during the lagoon management period, the project would result in an increased risk of structural damage or loss for properties just outside of the areas that would currently be inundated by tsunami-related flooding. There is no feasible mitigation for this potential impact and, therefore, it is considered significant and unavoidable.

Mitigation Measures

No mitigation measures available.

Impact Significance after Mitigation: Significant and Unavoidable.

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